CLAIMS

1. A liquid jet head comprising:

a passage-forming substrate in which pressure generating chambers communicating with nozzle orifices are formed, the passage-forming substrate being made of a single crystal silicon substrate; and

pressure generating elements for causing pressure changes in the pressure generating chambers,

wherein a protective film which is made of tantalum oxide and has resistance to liquid, is provided at least on inner wall surfaces of the pressure generating chambers.

2. The liquid jet head according to claim 1, wherein an etching rate of the protective film in a liquid at pH 8.0 or more is 0.05 nm/day or less.

3. The liquid jet head according to any one of claims 1 and 2, wherein the protective film is formed by ion assisted deposition.

4. The liquid jet head according to any one of claims 1 and 2, wherein the protective film is formed by facing-target sputtering.

5. The liquid jet head according to any one of claims 1 and 2, wherein the protective film is formed by plasma CVD.

6. The liquid jet head according to any one of claims 1 to 5, wherein liquid passages for supplying liquid to the pressure generating chambers are provided in the passage-forming substrate, and the protective film is provided also on inner wall surfaces of the liquid passages.

7. The liquid jet head according to any one of claims 1 to 6,

wherein the pressure generating elements are piezoelectric elements arranged on a vibration plate provided on one sides of the pressure generating chambers.

8. The liquid jet head according to claim 7, wherein the pressure generating chambers are formed in the single crystal silicon substrate by anisotropic etching, and each layer of the piezoelectric elements is formed by deposition and lithography.

9. The liquid jet head according to any one of claims 7 and 8, further comprising:

a sealing plate made of a single crystal silicon substrate, the sealing plate having a piezoelectric element holding portion for sealing a space sufficient enough so as not to inhibit movement of the piezoelectric elements in a state where the space is ensured,

wherein the sealing plate has a reservoir portion constituting at least part of a common liquid chamber common to the pressure generating chambers, and the protective film is provided at least on an inner wall surface of the reservoir portion.

10. A liquid jet head comprising:

a passage-forming substrate in which pressure generating chambers communicating with nozzle orifices are formed;

piezoelectric elements provided on one side of the passage-forming substrate with a vibration plate interposed therebetween, the piezoelectric elements causing pressure changes in the pressure generating chambers; and

a sealing plate made of a single crystal silicon substrate, the sealing plate having a piezoelectric element holding

portion for sealing a space sufficient enough so as not to inhibit movement of the piezoelectric elements in a state where the space is ensured,

wherein the sealing plate has a reservoir portion constituting at least part of a common liquid chamber common to the pressure generating chambers, and a protective film having resistance to liquid is provided at least on an inner wall surface of the reservoir portion.

11. The liquid jet head according to claim 10, wherein the protective film is provided on an entire surface of the sealing plate including the inner wall surface of the reservoir portion.

12. The liquid jet head according to any one of claims 10 and 11, wherein the protective film is a silicon dioxide film formed by thermally oxidizing the sealing plate.

13. The liquid jet head according to claim 10, wherein the protective film is made of dielectric material and formed by physical vapor deposition (PVD).

14. The liquid jet head according to claim 13, wherein the protective film is formed by any one of reactive ECR sputtering, facing-target sputtering, ion beam sputtering, and ion assisted deposition.

15. The liquid jet head according to any one of claims 13 and 14, wherein the protective film is made of any one of tantalum oxide, silicon nitride, aluminum oxide, zirconium oxide, and titanium oxide.

16. The liquid jet head according to any one of claims 13 to 15, wherein the protective film is formed on a joint surface of the sealing plate with the passage-forming substrate as well

as on the inner wall surface of the reservoir portion.

17. The liquid jet head according to claim 16, wherein interconnections for connecting the piezoelectric elements and a drive IC for driving the piezoelectric elements are provided on a surface of the sealing plate on an opposite side to the piezoelectric element holding portion.

18. The liquid jet head according to any one of claims 10 to 17, wherein the protective film is provided also on inner wall surfaces of the pressure generating chambers.

19. A liquid jet apparatus comprising the liquid jet head according to any one of claims 1 to 18.

20. A method of manufacturing a liquid jet head including a passage-forming substrate which is made of a single crystal silicon substrate and in which pressure generating chambers communicating with nozzle orifices are formed, and piezoelectric elements which are provided on one side of the passage-forming substrate with a vibration plate interposed therebetween and cause pressure changes in the pressure generating chambers, the method comprising the step of:

forming a protective film which is made of metal material and has resistance to liquid, at least on inner wall surfaces of the pressure generating chambers under a temperature condition of 150 °C or lower.

21. The method according to claim 20, wherein the protective film is formed by ion assisted deposition.

22. The method according to claim 20, wherein the protective film is formed by facing-target sputtering.

23. The method according to claim 22, wherein when the

protective film is formed, the passage-forming substrate is placed so that a longitudinal direction of the pressure generating chambers is perpendicular to a direction of surfaces of facing targets.

24. The method according to claim 20, wherein the protective film is formed by plasma CVD.

25. The method according to any one of claims 20 to 24, wherein the metal material is any one of tantalum oxide and zirconium oxide.

26. The method according to any one of claims 20 to 25, wherein after liquid passages for supplying liquid to the pressure generating chambers are formed in the passage-forming substrate, the protective film is formed also on inner wall surfaces of the liquid passages.

27. A method of manufacturing a liquid jet head including a passage-forming substrate in which pressure generating chambers communicating with nozzle orifices for jetting liquid are formed; piezoelectric elements which are provided on one side of the passage-forming substrate with a vibration plate interposed therebetween and cause pressure changes in the pressure generating chambers; and a sealing plate which is made of a single crystal silicon substrate and has a piezoelectric element holding portion for sealing a space sufficient enough so as not to inhibit movement of the piezoelectric elements in a state where the space is ensured, the sealing plate further having a reservoir portion constituting at least part of a reservoir communicating with the pressure generating chambers, the method comprising the steps of:

forming a mask pattern on a surface of a sealing plate forming material, which becomes the sealing plate;

forming the reservoir portion and the piezoelectric element holding portion by etching the sealing plate forming material except a region where the mask pattern has been formed;

removing the mask pattern to form the sealing plate;

forming a protective film having resistance to liquid at least on an inner wall surface of the reservoir portion in the sealing plate; and

joining the passage-forming substrate, in which the piezoelectric elements have been formed, and the sealing plate.

28. The method according to claim 27, wherein the protective film is formed on an entire surface of the sealing plate including the inner wall surface of the reservoir portion.

29. The method according to any one of claims 27 and 28, wherein the protective film made of silicon dioxide is formed by thermally oxidizing the sealing plate.

30. The method according to any one of claims 27 to 29, further comprising the step of:

forming interconnections for connecting the piezoelectric elements and a drive IC for driving the piezoelectric elements, on the protective film of the sealing plate on an opposite side to the piezoelectric element holding portion, after the step of forming the protective film.

31. The method according to claim 27, wherein the protective film made of dielectric material is formed by physical vapor deposition (PVD).

32. The method according to claim 31, wherein the protective

film is formed by any one of reactive ECR sputtering, facing-target sputtering, ion beam sputtering, and ion assisted deposition.

33. The method according to any one of claims 31 and 32, wherein the protective film is made of any one of tantalum oxide, silicon nitride, aluminum oxide, zirconium oxide, and titanium oxide.

34. The method according to any one of claims 31 to 33, wherein the piezoelectric element holding portion and the reservoir portion are formed by etching the sealing plate forming material by use of an insulation film as the mask pattern, the insulation film being formed by thermally oxidizing the sealing plate forming material.

35. The method according to claim 34, further comprising the step of:

forming interconnections for connecting the piezoelectric elements and a drive IC for driving the piezoelectric elements, on the insulation film, before the step of forming the piezoelectric element holding portion and the reservoir portion.